

OPPORTUNITIES FOR IMPLEMENTING THE BIOECONOMY IN THE PHARMACEUTICAL BUSINESS

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***Abstract.** The potential applications of the bioeconomy in a pharmaceutical company are examined in this research. The relevance of biotechnology in the pharmaceutical industry is substantiated, and the forecasts of the volume of biological products by 2028 are updated. New and long-term prospects for the global pharmaceutical industry are identified. The level of Bioeconomy employees, Value added per employee, Turnover per employee for 2015 and 2020 is studied. The Circular economy scheme is presented. We examine data on the bioeconomy's growth and the global demographic landscape, stress the importance of bioeconomic initiatives, and anticipate future developments for the bioeconomy over the next few decades. A real-life example of the development of the American pharmaceutical company Gilead Sciences under the influence of biotechnology is considered. A flowchart of the development of future bioeconomy is presented. Additionally looked into are the benefits of biotechnology and its successful application for multinational pharmaceutical corporations. It was shown that pharmaceutical firms can benefit from and grow as a result of using the bioeconomy.*

***Keywords:** bioeconomy, bioeconomy in pharmaceuticals, circular economy, sustainable development, pharmaceutical businesses, biotechnology.*

I. INTRODUCTION

The bioeconomy is an economic sector that leverages biological resources, principles, and processes to develop novel and effective goods and services that promote environmental preservation, societal well-being, and human health. The bioeconomy encompasses a number of economic areas, the pharmaceutical industry being one of the most dynamic and promising.

The pharmaceutical sector conducts research, develops, produces, and distributes medications for the purpose of diagnosing, treating, and preventing illnesses. But without appropriate coordination in the entrepreneurial realm, it cannot exist.

The process of starting, growing, and organizing a firm on the basis of competitiveness, risk-taking, creativity, and market opportunity identification and exploitation is known as entrepreneurship.

These three ideas are interconnected because pharmaceutical businesses now have more options to research and produce biological, biocompatible, biodegradable, and bioactive medications with reduced environmental impact, higher efficacy, and fewer adverse effects thanks to the bioeconomy. As significant users of biological resources, producers of biological goods and services, and providers of biological innovation, pharmaceutical businesses also play a role in the growth of the bioeconomy. The bioeconomy and the pharmaceutical industry both rely heavily on

entrepreneurship since it fosters innovation, problem-solving, seizing opportunities, flexibility in the face of change, and the formation of alliances and collaborations.

The ability to leverage biological resources, methods, and principles to develop novel medications, vaccines, diagnostic tests, and other goods and services that support and enhance human health is known as bioeconomy in the pharmaceutical industry.

The CPHI 2022 Annual Report What's in Store for Global Pharma in 2023 and Beyond (CPHI, 2022) states that approximately 400 pharmaceutical executives participated in the sixth annual CPHI poll, which evaluated the status of the major pharmaceutical markets as well as expected trends for 2023 [1]. Regarding biotechnology, the majority of CEOs have a more optimistic perspective for 2023; in fact, only 19% of them think the market would have severe negative growth over the next 12 months. A little over half believe that things will get better and that "the bottom of biotech funding has already been reached." On the other hand, 22% of experts predict extremely favourably and say that biotech stocks are now "valuable investments." In addition, there is also less competition in terms of startup financing, as external capital has left the market, leaving only investors who are true fans of biotechnology. "Overall, the most pronounced trend is the shift to biologics, and although small molecules still dominate approvals and sales, we forecast that by 2028 the share of biologics will reach only 55% of total drug sales. In fact, in 2028, sales of biologics will exceed those of small molecules," commented Quentin Horgan, Deputy Director of Pharmaceutical Data and Analytics at GlobalData.

This sector of the economy presents the world with a number of long-term opportunities, including:

- expanding the range and quality of pharmaceutical products through the use of biotechnology, which allows the development of new drugs with higher efficacy, safety and specificity, as well as the production of drugs that are difficult or impossible to obtain by other methods;

- boosting the competitiveness and inventiveness of pharmaceutical companies in both domestic and international markets;

- attracting investments in research and development;

- less reliance on imported medications, which boosts national energy and economic security and preserves healthcare sector sovereignty; - the creation of new jobs and staff professional development; - an increase in budget income from pharmaceutical activities;

- contribute to reaching sustainable development goals and addressing global issues like population increase, climate change, food, energy, and health.

Of course, in order to accomplish all of the objectives, significant issues and barriers that stand in the way of the bioeconomic future must be removed, such as

- inadequate financing for research and development; a deficiency of effective methods for commercializing biotechnological inventions; a low degree of collaboration between science, education, and business;

- the difficult and drawn-out process for pharmaceutical product certification, registration, and quality control; - the discrepancy between national and international standards; - the flaws in the legal and regulatory framework pertaining to the bioeconomy;

- fierce competition from foreign producers of pharmaceuticals; limited population purchasing power; and little public and governmental support for domestic businesses.

Therefore, in the following sections, we will consider in more detail the positive and negative aspects of the bioeconomy in pharmaceuticals and possible solutions for the present and future.

II. LITERATURE ANALYSIS

When considering the bioeconomy's role in the circular economy (Foschi, 2022) and sustainable development (Aguilar, 2019), it can be defined as the application of biological resources, processes, and principles to the development of new goods and services that satisfy consumer demands while also taking into account the environmental, social, and economic aspects of sustainable development [2; 3]. It also involves boosting the productivity, innovation, and competitiveness of various economic sectors and ensuring the population's health and well-being.

Because it contributes to lowering reliance on non-renewable resources, raising the proportion of renewable energy sources, cutting greenhouse gas emissions, protecting ecosystems and biodiversity, and shielding the environment from pollution and climate change, the bioeconomy also directly influences the growth of the circular economy.

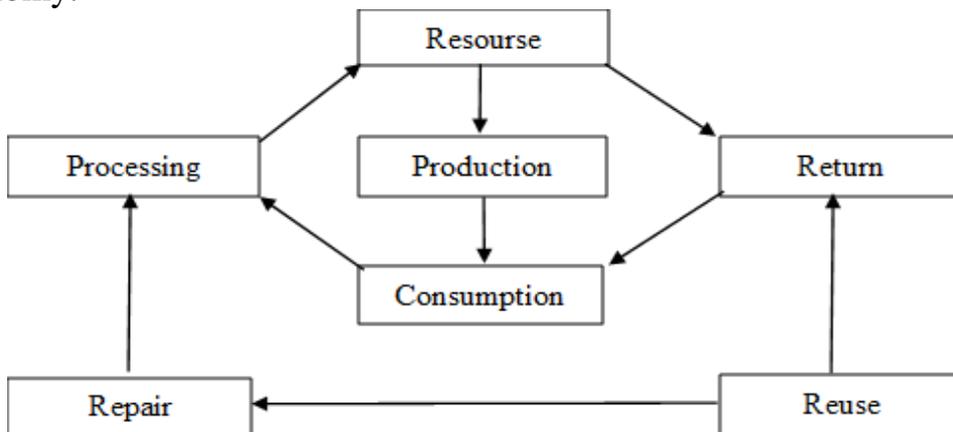


Fig. 1. Circular economy

Source: [4] <https://doi.org/10.21272/mer.2019.85.02>

On November 15, 2022, the world's population reached 8 billion, which was an important milestone in the development of mankind.

Population in the world is growing at a rate of around 0.91% per year in 2024 (up from 0.88% in 2023, and down from 0.98% in 2020, and 1.06% in 2019). The current population increase is estimated at around 73 million people per year.

Annual growth rate reached its peak in the late 1960s, when it was at around 2%. The rate of increase has nearly halved since then and will continue to decline in the coming years.

World population will therefore continue to grow in the 21st century, but at a much slower rate compared to the recent past. World population has doubled (100% increase) in 40 years from 1959 (3 billion) to 1999 (6 billion). It is now estimated that

it will increase by 50% in the subsequent 40 years, to reach 9 billion by 2037.

The latest world population projections indicate that world population will reach 10 billion persons in the year 2057 and 10.4 billion in 2100.

Table 1. World Population (2024 and historical data) and World Population Forecast (2025-2100)

Year (July 1)	Population	Yearly Change %	Yearly Change	Median Age	Fertility Rate	Density (P/Km ²)
2023	8,045,311,447	0,88 %	70,206,291	30.5	2.31	54
2024	8,118,835,999	0,91 %	73,524,552	30.7	2.31	55
2025	8,191,988,453	0,88 %	70,207,115	31	2.30	55
2030	8,546,141,327	0,85 %	70,830,575	32	2.27	57
2035	8,879,397,401	0,77 %	66,651,215	33	2.23	60
2040	9,188,250,492	0,69 %	61,770,618	34	2.21	62
2045	9,467,543,575	0,60 %	55,858,617	35	2.18	64
2050	9,709,491,761	0,51 %	48,389,637	36	2.15	65
2058	10,008,310,111	-	-	-	-	67
2100	10,349,323,038	-	-	-	-	69

Source: [5] <https://www.worldometers.info/world-population/>

To reduce the impact of this development vector on the environment, the economy and society must be re-designed. States should implement the "idea of inclusive development" to preserve and distribute wealth. Globalization, technological change, and innovation, which enable the entire society to develop, are just some of the key global drivers. Others, such as migration, urbanization, digitalization, smartification, integration, etc., will also shape global society and markets.

In such a situation, the current economic model has a systemic failure, assuming unlimited resources and their irrational use. It underestimates the environmental costs of its operation and the importance of natural capital for its long-term viability. It fails to create positive incentives for the market to move toward an economy that thrives within the natural renewable limits of our planet.

Inclusive growth means empowering people through high employment, investing in skills development, poverty reduction, and modernizing labor markets, training, and social protection systems to help people anticipate change and cohesion.

The European Commission will monitor the situation annually based on a set of indicators showing overall progress towards the goal of a smart, green and inclusive economy with high levels of employment, productivity and social cohesion.

The objectives of this policy are to develop a knowledge-based and innovation-driven economy, to promote a more efficient, environmentally friendly and competitive economy, and to foster a high employment economy that ensures economic, social and territorial cohesion. This policy defines strategies to (i) increase employment, (ii) improve the conditions for private sector R&D investment, (iii) reduce greenhouse gas emissions, increase the share of renewable energy and improve energy efficiency, (iv) improve education, and (v) reduce poverty (Europe, 2020).

Policies and strategies for smart, sustainable and inclusive growth are coordinated with bioeconomy policies and strategies.

Table 2. Smart, sustainable and inclusive development strategy

HEADLINE TARGET		
<p>– Raise the employment rate of the population aged 20-64 from the current 69% to at least 75%</p> <p>– Achieve the target of investing 3% of GDP in R&D in particular by improving the conditions for R&D investment by the private sector, and develop a new indicator to track innovation.</p> <p>– Reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in our final energy consumption to 20%, and achieve a 20% increase in energy efficiency.</p> <p>– Reduce the share of early school leavers to 10% from the current 15% and increase the share of the population aged 30-34 having completed tertiary education from 31% to at least 40%.</p> <p>– Reduce the number of Europeans living below national poverty lines by 25%, lifting 20 million people out of poverty.</p>		
SMART GROWTH	SUSTAINABLE GROWTH	INCLUSIVE GROWTH
<p><i>INNOVATION</i></p> <p>EU flagship initiative "Innovation Union" to improve framework conditions and access to finance for research and innovation so as to strengthen the innovation chain and boost levels of investment throughout the Union.</p>	<p><i>CLIMATE, ENERGY AND MOBILITY</i></p> <p>EU flagship initiative "Resource efficient Europe" to help decouple economic growth from the use of resources, by decarbonising our economy, increasing the use of renewable sources, modernising our transport sector and promoting energy efficiency.</p>	<p><i>EMPLOYMENT AND SKILLS</i></p> <p>EU flagship initiative "An agenda for new skills and jobs" to modernise labour markets by facilitating labour mobility and the development of skills throughout the lifecycle with a view to increase labour participation and better match labour supply and demand.</p>
<p><i>EDUCATION</i></p> <p>EU flagship initiative "Youth on the move" to enhance the performance of education systems and to reinforce the international attractiveness of Europe's higher education.</p>		
<p><i>DIGITAL SOCIETY</i></p> <p>EU flagship initiative "A digital agenda for Europe" to speed up the roll-out of high-speed internet and reap the benefits of a digital single market for households and firms.</p>	<p><i>COMPETITIVENESS</i></p> <p>EU flagship initiative "An industrial policy for the globalization era" to improve the business environment, especially for SMEs, and to support the development of a strong and sustainable industrial base able to compete globally.</p>	<p><i>FIGHTING POVERTY</i></p> <p>EU flagship initiative "European platform against poverty" to ensure social and territorial cohesion such that the benefits of growth and jobs are widely shared and people experiencing poverty and social exclusion are enabled to live in dignity and take an active part in society.</p>

Source: [6] <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC2020>

The European Union's development strategy, known as Europe 2020, calls for the creation of an inclusive, sustainable, and intelligent economy. This strategy, which calls for raising employment, allocating 3% of GDP to research and innovation, cutting greenhouse gas emissions by 20%, increasing the percentage of renewable energy to 20%, raising educational attainment, and reducing poverty by 25%, includes the bioeconomy as a key component.

Approximately half of all pharmaceuticals produced worldwide are produced in Europe, making it one of the most competitive pharmaceutical industries globally.

"EUROPE 2020: AN OVERVIEW" (COM (2010), 2020) states that the main goals of the initiative are to support EU development through sustainable, inclusive, and smart growth, and they represent the EU's priorities in the fields of employment, science, the environment, and social justice [6].

The European Union shall accomplish the five primary goals of the Europe 2020 strategy by 2020 in the areas of employment, research and development, energy and climate change, education, and poverty alleviation.

With the exception of the goal of decreasing poverty, four out of the five objectives have been met or surpassed by the EU as of 2020, according to Eurostat. Let's examine them in more detail.

1. Employment. The goal was to increase the employment rate of the population aged 20 to 64 to 75%. In 2020, this figure was 72.4%, which is the highest level since the beginning of the measurement.

2. Research and development. The goal was to increase spending on research and development to 3% of GDP. In 2020, this indicator amounted to 2.23%, which is the highest level since the beginning of the measurement. Only three EU member states (Sweden, Austria, and Denmark) met or exceeded this target.

3. Climate change and energy. The goal was to reduce greenhouse gas emissions by 20% compared to 1990, increase the share of renewable energy sources to 20% of total energy consumption, and increase energy efficiency by 20%. In 2020, the EU exceeded all three targets: greenhouse gas emissions decreased by 24%, the share of renewable energy sources increased to 20.1%, and energy efficiency improved by 24%.

4. Education. The goal was to reduce the number of people leaving school early to 10% and increase the number of people with higher education to 40%. In 2020, these indicators amounted to 9.9% and 40.3%, respectively, which are the best results since the beginning of the measurement. However, there are significant differences between EU member states, as well as between different population groups by gender, social status, ethnicity and migration status.

5. Fighting poverty. The goal was to reduce the number of people at risk of poverty or social exclusion by 20 million. In 2020, this figure increased by 1.8 million compared to 2008, reaching 91.4 million people. This means that almost one in five EU citizens is experiencing poverty or social exclusion⁶. The main reasons for this are high unemployment, low incomes, inequality, discrimination and insufficient social protection.

Based on the document [7], which contains four scenarios for the development of the bioeconomy in Europe until 2050, here is a table that shows the main indicators for each of these scenarios.

Table 3. Scenarios for Europe by 2050

Scenario	Description	Expected Development
Do it for us	Radical changes in the supply systems, but society resists significant changes in demand (consumption) away from Business As Usual (BAU)	Low
Do it together	Both the political system and society are aligned to achieve the climate-neutrality goal and the SDGs. Businesses quickly adapt and are part of the change. The transformative process includes all actors.	High
Do it ourselves	The political system shows an incapacity to implement significant climate and SDG policies. However, consumers change their attitudes and behaviour under the thrust of increasingly influential social movements and the aftermath of a series of dramatic crises. Subsequently, the resulting change in demand (both patterns and levels) drives the supply system to adapt.	Medium
Do what is unavoidable	Lifestyles do not change significantly from BAU patterns (but consumption levels rise), and the political system is not able or supportive to implement/enforce proactive policies, limiting itself to adopt – with some delay – measures in reaction to crises.	Low

Source: [6] https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/european-bioeconomy-2050-four-foresight-scenarios-2021-04-12_en

We are able to forecast scenarios of the bioeconomy in Europe by 2050 because of the project's favourable outcomes. The Europe 2020 strategy has also helped bioeconomic development because it has encouraged the use of biotechnology and biological resources to develop new goods and services that satisfy consumer demands and take into account the social, economic, and environmental aspects of sustainable development. Agriculture, forestry, fishing, food, biotechnology, medicines, energy, and other industries are all included in the bioeconomy.

One of the most exciting and active industries in the world today is the bioeconomy in pharmaceuticals, which offers enormous potential for advancements in science, technology, innovation, competitiveness, exports, and jobs. The OECD estimates that the global biopharmaceuticals market was valued at USD 300 billion in 2018 and was growing at an average annual rate of 8.5% (State Statistics Service of Ukraine). The EU, China, India, Japan, Canada, and the United States are the major participants in this market [8; 9].

Let's look at some instances of how the bioeconomy in the US or Canada has helped pharmaceutical businesses solve their problems:

The United States established the National Institutes of Health (NIH), the largest government funder of biomedical research worldwide, to boost financing for research and development. In order to help scientists, colleges, hospitals, pharmaceutical firms, and other organizations create novel medications, vaccines, diagnostic tools, and other goods and services that support and enhance human health, the NIH awards grants and contracts.

Canada created Health Canada, a federal organization in charge of overseeing the pharmaceutical sector, to streamline and expedite the registration, certification, and quality control of pharmaceutical products. This organization performs scientific research, sets criteria for the efficacy, safety, and quality of pharmaceutical products, and authorizes the sale of novel medications, vaccines, diagnostic tests, and other goods and services that support the maintenance and enhancement of human health.

The US and Canada are establishing their own domestic bioresource production and utilization in order to lessen their reliance on imported medications. This includes employing biotechnology to create medications from plants, animals, microbes, and other biological sources. For instance, *Escherichia coli* bacteria that have undergone genetic modification are used in the United States to make insulin, a hormone that is essential for controlling blood sugar levels in diabetics. *Saccharomyces cerevisiae* yeast, which has undergone genetic modification to create an antigen that stimulates the human immune system to guard against the hepatitis B virus, is used in Canada's production of the hepatitis B vaccine.

Although Ukraine has made considerable progress in the bioeconomy of pharmaceuticals, its market share worldwide is still quite tiny. The State Statistics Service of Ukraine reports that UAH 24.4 billion was produced in pharmaceuticals in 2019 and that USD 1.1 billion was exported [10].

But rather than biotechnological drugs, the majority of Ukrainian pharmaceutical enterprises manufacture conventional ones. In 2019, just 3% of pharmaceutical businesses in Ukraine had research laboratories, and 1% had their own research facilities, according to the Association "Pharmaceutical Firm "Darnitsa" [11].

As a result, Ukraine must raise its research and development spending, strengthen the competencies of its workforce, encourage the founding and growth of creative businesses, enhance the regulatory framework, and collaborate with foreign partners in the bioeconomy of pharmaceuticals.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The pharmaceutical business might benefit greatly from increased productivity, innovation, and competitiveness as well as improved population health and well-being if the bioeconomy is implemented. It encourages the creation of novel medications, immunizations, diagnostic tools, medical equipment, and services utilizing biotechnology and biological resources.

The bioeconomy is not without its difficulties, though. These include the scarcity and poor quality of biological resources, the high costs associated with research and development, the difficulty of regulating and standardizing biological products, and the moral and societal concerns surrounding the use of genetic information and biological material.

Increasing investment and funding for research and innovation, encouraging interdisciplinary and cross-sectoral cooperation, raising the educational and qualification standards of specialists, creating transparent and harmonized regulatory frameworks, guaranteeing the safety and ethics of biological products, and involving the public and stakeholders in the bioeconomy are all necessary steps to address these

shortcomings and support the development of the bioeconomy in pharmaceuticals [12].

Let's look at a concrete illustration of how biotechnology has impacted the growth of the American pharmaceutical company Gilead Sciences.

An American pharmaceutical business called Gilead Sciences is focused on creating and manufacturing medications to treat hepatitis, HIV/AIDS, and other illnesses [13].

The business develops novel medications that are safer and more effective for patients by using biotechnology. Among its most well-known medications are:

1. The first and only medication licensed for treating COVID-19 in the US and other countries is called Veklury (remdesivir). The medication stops the virus from replicating in cells by using biotechnology.

2. The first CAR T-cell immunotherapy medication for the treatment of adult patients with specific types of lymphomas is called Yescarta (axicabtagene whole-cell). Through the application of biotechnology, the medication alters a patient's immune system to enable it to identify and eliminate cancerous cells.

3. The first medication taken orally to treat chronic hepatitis C is Sovaldi (sofosbuvir). The medication blocks viral polymerase, which is required for the virus to multiply, using biotechnology.

As one of the top biotechnology firms in the world, Gilead Sciences' high income is probably due to its accomplishments in the creation and marketing of novel medications, as well as the growth of its international clientele. In Table 2, approximate figures are displayed [14].

Table 2. Gilead Sciences's revenue from 2019 to 2022

Year	Revenue, million dollars
2022	27,391
2021	27,281
2020	24,682
2019	22,449

Source: [14] <https://www.macrotrends.net/stocks/charts/GILD/gilead-sciences/revenue>

The development of Gilead Sciences has been impacted by biotechnology in a number of ways. These include the ability to create novel and cutting-edge medications that can treat a wide range of illnesses, from cancer to viruses; the ability to maintain high standards of quality and safety for its products that comply with international regulations and standards; the ability to enhance the company's competitiveness and leadership in the global pharmaceutical market; and the increased opportunities for research and collaboration with other institutions and organizations involved in the bioeconomy and biotechnology.

Let's examine Roche, a leading pharmaceutical and biotechnology corporation based in Switzerland. It develops and produces biological products to treat a range of illnesses, including cancer, diabetes, anemia, hemophilia, rheumatoid arthritis, hepatitis, HIV/AIDS, and others. It invests hundreds of millions of dollars in biotechnology each year. To develop novel and improved patient solutions, the company employs biotechnology techniques such genetic engineering, cell therapy, monoclonal antibodies, biospecific drugs, biomarkers, bioinformatics, and others.

Take action to examine more closely at Figure 2 to see how biotechnology will impact the bioeconomy in the future.

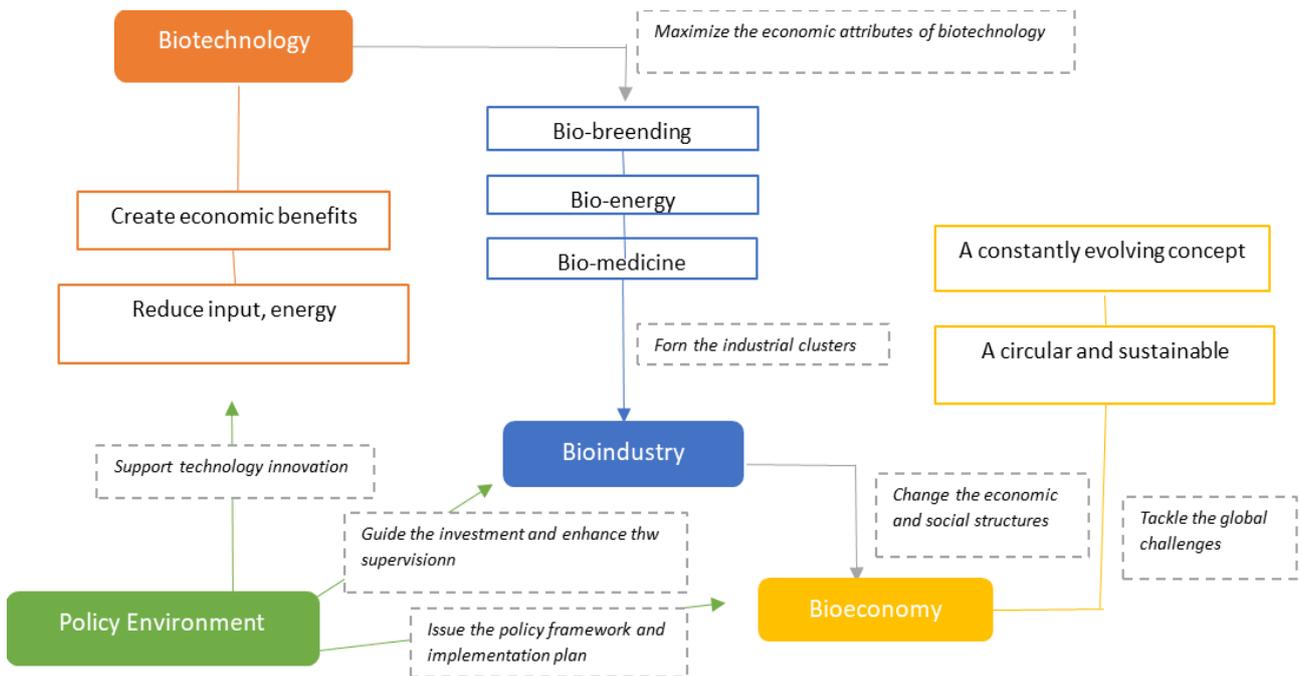


Fig. 2. A flowchart of the development of future bioeconomy

Source: [15] <https://www.mdpi.com/2071-1050/14/16/10413>

Put differently, the bioeconomy's direct influence on the pharmaceutical industry not only makes it possible to develop novel, high-quality, and reasonably priced medications that can cure anything from cancer to viruses. Additionally, it makes it possible to use biological systems and organisms to create human-useable products that can be safer and more effective for patients; to raise food products' nutritional value, which can enhance human health and nutrition; and to support the growth of the bioeconomy, which can create jobs and boost the economy.

IV. RESULTS

The interaction between the bioeconomy and pharmaceutical companies is to use biological resources, processes, and principles to create new pharmaceutical products and services that meet consumer needs and requirements while also taking into account the environmental, economic, and social aspects of sustainable development, according to the analysis and research findings. Both the population's health and well-being and the pharmaceutical industry's competitiveness and innovation are enhanced by this relationship.

On the one hand, the bioeconomy supplies biomass, biotechnology, and biological resources to the pharmaceutical industry, enabling them to create new biological products. Conversely, the pharmaceutical sector fosters innovation, jobs, value addition, and social benefits that support the bioeconomy. The bioeconomy and the pharmaceutical sector do, however, also confront a number of obstacles and shortfalls, including the scarcity and competition for biomass, the high costs associated with research and development, the low commercialization speed and efficiency, the lack of funding and regulations, the ethical and legal ambiguities, the low level of

consumer awareness and demand, etc [15].

A thorough and coordinated strategy that considers the needs and interests of all stakeholders is required to address these issues and weaknesses. Among the potential fixes are:

To increase biomass productivity and quality, create new biotechnologies and bioproducts, lower production costs, and guarantee safety and effectiveness, more money is being invested in research and innovation.

Encourage the creation and implementation of a circular and sustainable bioeconomy that makes use of renewable energy sources, minimizes waste and pollution, and assures the effective use and recycling of biological resources.

Enhancing partnerships and collaborations between the pharmaceutical industry, various bioeconomy sectors, and scientific, educational, industrial, public, and governmental organizations in order to collaboratively solve issues, exchange information, resources, and technologies, and develop projects and initiatives.

Utilizing information campaigns, training, consultations, demonstrations, incentives, and certification to increase demand and awareness for bioproducts among consumers, physicians, patients, and other stakeholders.

To guarantee the protection of intellectual property, biosafety, bioethics, quality, and efficacy of biological products, as well as to promote international commerce and collaboration, the legislative and regulatory framework for the bioeconomy and the pharmaceutical sector must be harmonized and made simpler.

Depending on their unique environmental, economic, social, and political circumstances, various nations have varied plans and initiatives for the growth of the bioeconomy and pharmaceutical business. For instance, because to large investments in R&D, a competitive market, robust intellectual property rights, and efficient regulation, the United States leads the world in biotechnology and biomedical innovation [16]. The European Union's development strategy, known as Europe 2020, calls for the creation of an inclusive, sustainable, and intelligent economy. Approximately half of all pharmaceuticals produced worldwide are produced in Europe, making it one of the most competitive pharmaceutical industries globally.

V. CONCLUSIONS

The study's findings allow us to sum up the bioeconomy as a novel economic strategy that guarantees the conservation of natural resources and their sensible usage by making better use of biological raw materials. Enhancing people's quality of life, making the economy more competitive, lowering reliance on imported energy and raw materials, conserving ecosystems and biodiversity, and shielding the environment from pollution and climate change are all possible benefits of the bioeconomy. The bioeconomy also fosters the creation of novel technologies, particularly in the biotechnology sector, which has applications in the pharmaceutical industry for the development of novel drugs, vaccines, diagnostic tools, gene therapy, etc.

Because of its strategic location, scientific foundation, highly skilled labor force, and plenty of natural resources, Ukraine has enormous potential for the establishment of a bioeconomy. However, a good scientific understanding of the bioeconomy's

development, a legal framework, and efficient, creative methods to promote the application of scientific advancements in production are required in order to bring the principles of the bioeconomy to reality in Ukraine.

The European Union, the US, Canada, China, Japan, Brazil, India, and other nations can also profit from the bioeconomy. These nations have created and executed national bioeconomy development plans and initiatives, which include fostering international collaboration and experience sharing, involving stakeholders, improving scientific and innovative potential, and establishing a supportive institutional and financial environment.

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